PREVENTING THE MAILLARD REACTION IN SYNTHETIC DIETARY COMPOSITIONS

BACKGROUND OF THE INVENTION

1. Field of the Invention

Most natural and processed foods contain one or more of intact protein, predigested protein (protein hydrolysates), amino acids and non-protein nitrogen. These nutrients are the building blocks of lean body mass (protein) and other nitrogen containing metabolites (for example, enzymes, vitamins, hormones, etc.). Carbohydrates normally present in foods can be simple (for example, dextrose, fructose, etc.) or very complex in nature (for example, fiber, pectin, starch, predigested starch [hydrolyzed cereal solids, dextrose oliogosaccharides, etc.], dextrin, etc.). Carbohydrates in foods supply energy, and desirable psychosensory benefits, such as taste and texture.

This invention concerns essentially residue free dietary compositions for supplying nitrogen nutritional requirements to users whose normal digestive processes are imparied as, for example, patients in catabolic disease states such as duodenal fistula, the short gut syndrome, pancreatitis, ulcerative colitis, and the like, as well as to pre- and post operative patients who are required to eliminate temporarily solid residues from their diet because of surgical intervention. The low residue compositions, designed to be readily absorbed in the duodenum and jejunum, result in minimal intestinal digestive activity and reduced frequency of defecation, with the quantity of fecal matter reduced to essentially endogenous amounts.

More particularly, the invention concerns solid dietary compositions (or concentrates) comprising at least one amino acid or other nitrogen containing material (nitrogen compound) and at least one carbonyl group-containing material (carbonyl compound) such as a reducing sugar, in admixture therewith, wherein the shelf life of the composition is extended by separating the nitrogen compound from the carbonyl compound with another, non-nitrogenous, relatively non-reducing ingredient of the dietary composition, namely a starch having a D.E. (Dextrose Equivalent) number of from 0 to about 24 so as to prevent or retard the Maillard-type browning reaction (hereinafter "Maillard reaction") between the nitrogen compound and the carbonyl group containing material. As used herein, the term starch includes the native starches and their derivatives (e.g. dextrin or chemically or enzymatically modified starch, commercially available as dextrose [or glucose] polymer, dextrose [or glucose] oligosaccharides, corn syrup solids, hydrolyzed starch or hydrolyzed cereal solids). By the expression "carbonyl group-containing material" or "carbonyl compound" as used herein is meant a compound wherein the carbonyl group is either a keto or aldehyde group. In accordance with the invention, the reactive compounds are separated by interposing the starch between the reactive components, typically by coating one or both of the nitrogen-containing material and the carbonyl group-containing material with the starch.

Many synthetic foods and special dietary products exist which contain, among other nutrients, amino nitrogen-containing (proteinaceous) compounds (e.g. one or more free amino acids or their salt derivatives, protein hydrolysates, intact whole proteins, or a combination of these) plus vitamins, including amino nitrogen containing vitamins, e.g. para-amino-benzoic acid (PABA), thiamine, niacin, choline, riboflavin, ascorbic acid, etc. and their derivatives, plus other, non-amino nitrogen-containing compounds, e.g. ammonium compounds such as ammonium sulfate, plus carbohydrates, including reducing sugars, e.g. glucose (also known as dextrose), fructose (also known as levulose) and 5-carbon or pentose sugars such as xylitol (also commonly called xylose), and other aldehyde containing compounds which may be found, for example in flavoring agents. Even non-reducing disaccharide sugars (e.g. sucrose, lactose, maltose, and their derivatives) may be hydrolyzed catalytically to produce the reducing sugar moiety, this reaction being promoted by the presence of moisture and elevated temperatures.

Over time, in the presence of moisture, and in even moderate heat (i.e. at temperatures above the freezing point of water), the Maillard/browning reaction results from the interaction of the nitrogen compounds with the aldehyde groups of the reducing sugars or other carbonyl compounds.

In some instances, a "browning" reaction is desirable — for example with butterscotch confections, caramel, cooked meats, etc. In other instances this reaction is objectionable — for example with fluid and dried milk and with special dietary products containing amino acids, hydrolyzed protein or intact protein.

When browning occurs in, for example, an elemental diet (a white powder composed of purified amino acids, carbohydrate, fat, vitamins, minerals and flavorings which, when reconstituted with water to a beverage, semi-solid or solid food, provides all nutrients known to be essential to the suport of human life) or in any other form of nutrient defined diet, the resulting color change can be expected to be found objectionable by users. So, too, can the concomitant changed organoleptic qualities, for example, a bitter, metallic taste and an associated acrid, pungent odor. Even more important, the Maillard reaction can actually alter the nutritional values of the product. For example, chemical analysis of such a total elemental diet which had undergone the Maillard reaction while being aged 24 months at 40° F. (4.4° C.) showed a reduction in the level of PABA to 40% below the amount contained in the product at the time of manufacture.

Such elemental diets are described, for example, in U.S. Pat. Nos. 3,773,930, issued Nov. 20, 1973, entitled "Amino Acid Compositions" and 3,821,432, issued June 28, 1974, entitled "Bland Amino Acid Compositions." They contain, among other nutrients, a blend of purified amino acids, free glucose and PABA. Other special dietary foods have been developed which contain amino acids, protein hydrolysates and whole protein, singly or in combination, as well as reducing sugars and, optionally, nitrogen containing vitamins. All of these dietary foods have been shown to suffer from short shelf lives of from six months to one year when stored at ambient temperatures (up to about 86° F. [30° C.]). This has been true even when product moisture levels have been reduced to less than 2% and expensive moisture barrier laminates have been used for packaging. Generally, the higher the finished product temperature and moisture content, the more pronounced or rapid the resultant Maillard reaction will be.

2. Description of the Prior Art

The Maillard reaction has been recognized as a limiting factor on the shelf-life of compositions with which the present invention is concerned, including concen-